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DESHYDRATATION DES DENREES ALIMENTAIRES EN PAYS DE LA ZONE TROPICALE (AFRIQUE)

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I) INTRODUCTION

Parmi les diverses méthodes de conservation des denrées alimentaires, la deshydratation constitue l'une des plus anciennes, sinon la plus ancienne, et ses applications ont intéressé et intéressent encore une gamme variée de produits. Cependant, durant le siècle dernier se sont développés, à la suite des découvertes scientifiques d'alors, des méthodes nouvelles et principalement celles faisant appel à la stérilisation, qu'elle soit réalisée par agents physiques, chimiques ou biologiques.

La deshydratation, en tant que méthode de conservation, constitue un cas particulier d'une méthode générale de conservation des produits périssables à savoir l'élévation de la concentration du suc cellulaire, de façon que les produits ne puissent plus être altérés. En effet non seulement la réduction de la teneur en eau arrête l'évolution vers la destruction, mais également évite que des micro-organismes ne s'y développent.

Selon le dégré atteint par cette réduction de la teneur en eau, et le produit de départ, on parle de concentration, séchage ou deshydratation, ce dernier terme semblant indiquer une réduction plus poussée de la teneur en humidité et comportant généralement une évacuation d'eau importante : on sèche du blé pour réduire son humidité à 14 - 16 % ; la teneur en eau du lait deshydraté ne doit pas excéder 4 à 5 %

Dans la suite c'est plus spécialement de la deshydratation ainsi définie que nous allons traiter et afin d'étudier ses possibilités d'application en pays de la zône tropicale, nous indiquerons tout d'abord quel intérêt cette méthode peut y présenter, puis nous rappellerons brièvement les procédés de deshydratation.

II) INTERET DE LA DESHYDRATATION EN PAYS TROPICAUX

Un certain nombre de denrées alimentaires séchées sont d'usage courant dans les pays de la zone tropicale. C'est ainsi que les légumes et condiments séchés entrent depuis longtemps dans la préparation de la plupart des mets qui y sont consommés.

En effet, les plats traditionnels comprennent :

- le composant de base (bouillie ou couscous) préparé le plus souvent à partir des céréales locales, mil, sorgho, et plus rarement maïs, riz, fonio.
- une sauce, laquelle joue un rôle important :
  - tout d'abord elle permet de donner de la variété aux goûts des différents plats,
  - mais surtout, si le composant à base de farine donne la plus grande partie de la ration énergétique et l'essentiel de la ration glucidique et s'il fournit au consommateur la "plénitude gastrique", la sauce apporte les éléments protidiques dont les acides aminés essentiels, les lipides, les éléments minéraux importants et les vitamines. La sauce est en effet composée de légumes, parfois de viandes ou de poissons, de corps gras et de condiments.

Certaines denrées sont d'un emploi quasi permanent du fait tant de leur production assez répandue que de leur conservation aisée par séchage. Ces produits consommés soit frais, soit séchés, sont principalement l'oignon, la tomate, le piment, le gombo, les feuilles de baobab et condiments divers et ils sont présentés en permanence sur les marchés des villes et villages.

L'intérêt de la consommation de produits deshydratés revêt dans ces pays des aspects multiples en relation avec :

1) Le climat : le climat des zones tropicales (soudaniennes, sahéliennes ou sub-sahariennes) se caractérise par des températures élevées, un degré hygrométrique de l'air généralement faible, particulièrement en saison sèche, et une saison de pluies concentrée principalement en juillet - août et septembre. Le degré hygrométrique moyen faible (il varie à NIAMEY de 17 % en février-mars à 60 % en août ; à FORT-LAMY de 7 % en février à 65 % en août) est particulièrement favorable à la conservation des denrées alimentaires par séchage. Cette méthode s'applique d'autant mieux aux légumes et condiments que ceux-ci sont généralement produits en dehors de la saison normale de culture qui correspond à l'hivernage, et qui est plus particulièrement réservée à la production des aliments de base, les céréales. Ils sont produits à partir de terrains de culture irrigués et leur récolte se situe dans la période février-mars, c'est-à-dire à une période propice à leur séchage : degré hygrométrique bas, pluviomètre pratiquement nulle, vents secs fréquents.

Le climat, d'autre part, est beaucoup moins favorable à l'application d'autres méthodes de conservation et notamment la température élevée ne peut que rendre plus onéreuse et moins aisée la conservation des produits en frais par le froid.

2) Les distances de transport et le volume de stockage : les distances de transport des denrées alimentaires vont en s'accroissant avec le passage progressif de l'agriculture de subsistance à celle d'une économie d'échanges. Ces distances très élevées grèvent lourdement ces possibilités d'échanges d'une contrée ou d'un pays à l'autre. Dans ces conditions, il est bien préférable et beaucoup plus économique d'éviter un transport inutile d'eau en s'adressant à des denrées deshydratées.

Le moindre volume sous lequel se trouvent ces produits permet d'avoir des capacités de stockage beaucoup plus réduites que dans le cas de conservation en l'état. Les investissements à réaliser seront donc moindres et les conditions de milieu de ces entrepôts ne comporteront pas d'impératifs délicats ou onéreux à respecter.

Distances de transport élevées et volume de stockage réduit rendent la deshydratation plus intéressante comme méthode de conservation que l'appertisation ou l'utilisation d'antiseptiques divers.

Ce peut être grâce à de tels procédés que pourra être mise pleinement en valeur une richesse telle que celle découlant de produits de l'élevage comme cela s'est déjà réalisé pour ceux de la pêche.

3) L'équipement ménager : l'utilisation du froid dans l'équipement ménager, qui ne touche que quelques consommateurs privilégiés, ne peut entrer en ligne de compte dans la conservation des produits alimentaires au stade de l'utilisateur. En règle générale seuls sont utilisés les produits conservés en récipients appertisés ou deshydratés.

Il est intéressant de noter que les conditions d'utilisation de ces denrées (place disponible - matériel de cuisine de petites dimensions) indépendamment de toute question de prix d'achat du produit, incitent à l'emploi sous forme deshydratée.

La conservation par deshydratation des denrées alimentaires apparaît donc comme une solution très intéressante pour les pays en voie de développement ; elle est d'ailleurs pratiquée depuis fort longtemps, mais d'une façon encore artisanale et les produits obtenus ne sont pas d'une qualité parfaite. En outre les échanges se développent surtout avec des régions de caractères climatiques et par suite de productions agricoles différentes. Par exemple l'oignon de la région sahélienne du Mali et Niger s'exporte vers les zones côtières du Ghana, Côte d'Ivoire, Dahomey ... Mais dans ces pays de degré hygrométrique beaucoup plus élevé, les denrées déshydratés, naturellement hygroscopiques, demandent un emballage approprié afin que soit assurée leur conservation.

III) LES METHODES ET APPAREILS DE DESHYDRATATION

Le séchage au soleil ou à l'air est la méthode la plus simple et nécessitant le moins d'investissements. C'est la seule qui soit utilisée pratiquement à l'heure actuelle dans les pays en voie de développement entrant dans le cadre de cette étude. Nous venons de voir que les conditions réunies en zone sahelo-soudanienne sont favorables à ce procédé, mais la qualité des produits obtenus nécessite des améliorations à rechercher parmi les méthodes de déshydratation artificielle qui ont été mises au point et utilisées dans des pays à climat moins favorable.

Ces différentes techniques procèdent du même principe, à savoir créer dans le milieu ambiant une tension de vapeur inférieure à celle de l'eau contenue dans le produit à déshydrater. Elles peuvent être classées en quatre catégories :

1) Déshydratation par action de la chaleur

La première méthode envisagée a été de chauffer le produit à traiter. Cependant certaines limites dans ce chauffage ne peuvent être dépassées car la trop grande élévation de température d'une denrée alimentaire peut avoir des conséquences préjudiciables au produit, surtout si ce dernier est en contact avec de l'oxygène :

- coagulation et brunissement des protides,
- destruction des glucides, caramélisation,
- rancissement des lipides,

réactions qui se traduisent par l'apparition de couleurs indésirables et d'odeurs désagréables et la modification des qualités organoleptiques.

Selon que la chaleur est transmise par l'intermédiaire d'une paroi ou d'un gaz, l'air généralement, on distingue les procédés :

- par contact
- par mélange

11 - Procédés par contact avec une paroi chaude

Ces procédés s'adressent plus particulièrement à des denrées à phase liquide prédominante. Le plus connu des appareils mettant en oeuvre cette technique est le déshydrateur à tambours rotatifs (type Hatmaker) où la solution à déshydrater est répartie en couche mince sur un ou, plus généralement, deux cylindres horizontaux animés d'un mouvement de rotation lente et chauffés intérieurement par de la vapeur à 130-150° C.

La pression de vapeur varie de 4 à 6 Kg/cm2 et la consommation est de l'ordre de 1,25 Kg par Kg d'eau évaporée.

Ce procédé relativement économique, présente l'inconvénient majeur d'entraîner une élévation de température du produit allant jusqu'à 90/100° C qui provoque dans le sein du produit des réactions irréversibles, telles que la coagulation des protéines qui font que la reconstitution du produit d'origine est impossible.

12 - Procédés par mélange

Dans ce procédé l'apport de chaleur est assuré par de l'air (ou un gaz inerte) préalablement chauffé et activement renouvelé. Les appareils sont très divers et selon que l'on a à traiter des produits à phase solide prédominante ou non l'on fait plus spécialement appel aux séchoirs et à l'atomisation.

121 - Les séchoirs utilisés pour les denrées alimentaires varient selon les denrées et le débit à traiter, la finesse de travail désirée et les frais d'investissements admissibles ; en principe le chauffage doit être indirect, c'est-à-dire ne doivent pas se mélanger à l'air de séchage les gaz de combustion provenant de la source de chaleur.

- Les séchoirs à cases constituent le type d'appareil le plus simple. La ventilation peut être naturelle ou forcée et le fonctionnement est discontinu.

- Les séchoirs-tunnels procèdent d'une recherche dans la continuité du travail et la circulation de l'air peut y être méthodique, c'est-à-dire qu'au cours de sa progression la denrée à déshydrater, qui est répartie sur des plateaux portés par des chariots mobiles, passe dans des zones où le degré hygrométrique est de plus en plus faible et la température de plus en plus proche de la température de chauffage de l'air.

- Les séchoirs à tablier transporteur, à colonnes, à plateaux et à tambours rotatifs ont un fonctionnement pratiquement continu et il est également recherché une circulation méthodique de l'air chaud.

122 - Dans la déshydratation par atomisation, type procédé Spray, le mélange liquide à traiter est pulvérisé à la partie supérieure d'une tour et est immédiatement mélangé à de l'air chauffé à une température suffisamment élevée (130/160° C) pour qu'en liaison avec la grande surface d'échange ainsi réalisée, la déshydratation soit pratiquement instantanée tout en n'entraînant pas une élévation de température excessive pour le produit traité (50/60° C).

La gamme des appareils relevant du procédé par mélange d'air chaud est telle que les avantages et inconvénients propres à chacun sont divers. Les premiers sont d'un emploi simple., économique du point de vue combustible mais relativement exigent en main-d'oeuvre ; l'atomisation nécessite une main-d'oeuvre réduite, mais bien qualifiée, ainsi qu'une énergie beaucoup plus importante, puisque l'on compte de 2,5 à 2,7 Kg de vapeur par kg d'eau évaporé. Tous ont l'inconvénient commun d'entraîner une élévation de température du produit qui lui est préjudiciable.

C'est la recherche d'une meilleure qualité du produit déshydraté qui a conduit à l'application de méthodes nouvelles.

2) Déshydratation par action de la chaleur et sous vide partiel

Dans le but de réduire les températures mises en jeu, la première idée appliquée a été de réduire les températures d'évaporation en effectuant la déshydratation dans une enceinte où est réalisé un vide partiel.

Les appareils fonctionnant selon ce principe sont soit à marche discontinue soit à marche continue et, à fortiori dans ce dernier cas, sont nécessaires des équipements accessoires (pompe à vide, éjecteur, condenseurs, écluses à air ...) qui rendent ces séchoirs d'un prix élevé et également d'un fonctionnement délicat.

La rapidité du séchage, de même que la qualité du produit sont améliorés en créant une expansion du produit (Puff-drying).

3) Déshydratation par de l'air sec

Dans ce procédé la déshydratation est obtenue par mise en contact de la denrée avec de l'air dont le degré hygrométrique est suffisamment faible pour éviter toute élévation de température.

Les premiers essais portant sur les fruits et légumes ont été effectués il y a une dizaine d'années aux U.S.A. : la dessication de l'air était assurée par passage sur du silica-gel.

Le procédé BIRS utilise de l'air préalablement stérilisé et séché. Cet air dont le degré hygrométrique est de l'ordre de 3 % et dont la température n'excède pas 30° C est envoyé au bas d'une tour de déshydratation dont le diamètre est fonction du débit d'eau à évacuer et dont la hauteur doit être suffisante (l'usine d'Isola près de Sienne a une tour de 75 m de haut) pour que le produit dispersé en particules fines (300 à 2.000 µ) à quelques mètres du sommet parviennent au fond à l'état de poudre après une chute lente dont la durée varie de 50 à 200 secondes.

Ce procédé qui s'applique à des produits à l'état liquide ou pâteux présente l'avantage de n'occasionner aucun choc thermique. Les qualités du produit d'origine sont préservées et la poudre obtenue peut aisément être remise en solution.

Le fonctionnement d'une usine BIRS exige peu de main-d'oeuvre, mais elle doit être de bonne qualification. La consommation de vapeur est de l'ordre de 2 Kg de vapeur par kg d'eau évaporée. L'inconvénient de ce procédé est de nécessiter des investissements très importants et de ne pouvoir être envisagé que pour des tonnages importants de produits, de préférence de valeur élevée.

4) Déshydratation et froid

Toujours dans le but d'améliorer la qualité des denrées déshydratées a été envisagée l'action du froid, la congélation notamment.

41 - Son intervention peut se situer après la déshydratation, cette dernière n'étant alors que partielle, et avoir pour objectif la conservation sous forme congelée du produit obtenu. Dans cette méthode, ou déshydro-congélation, la déshydratation n'étant que partielle, l'influence de l'élévation en température est réduite d'une part car moins poussée, d'autre part car elle affecte un produit dont la teneur en eau est encore notable et par suite moins préjudiciables sont les chocs thermiques.

Par ce procédé est obtenue une bonne reconstitution des produits d'origine, mais le stockage ne peut naturellement être effectué que sous régime de froid poussé (- 18° C).

42 - La lyophilisation ou cryo-dessication met en jeu tout d'abord l'action d'un froid intense en vue de congeler rapidement la denrée à traiter (température de l'ordre de - 30° C) puis l'action de la chaleur et du vide pour assurer la sublimation de la glace puis l'extraction de l'humidité résiduelle. Le chauffage se fait par des plaques chauffantes où circule de l'eau dont la température varie de 120° C à 60° C et qui peuvent grâce à un système hydraulique exercer une pression uniforme sur chaque plateau de l'ordre de 0,55 Kg/cm2 (procédé Accelerated Feeze-Drying). La déshydratation finale est réalisée à 60° C.

Cette méthode est entrée depuis peu dans le domaine industriel et l'intérêt qu'elle soulève est grand car la qualité des produits obtenus est incomparable.

Les inconvénients sont son fonctionnement discontinu, la longueur de chacun des traitements, l'habileté pour la conduite de l'opération et son prix de revient, qui bien qu'allant en décroissant au fur et à mesure des études, reste encore élevé : pour évaporer un kg d'eau de la denrée, la consommation de vapeur est de l'ordre de 1,8 Kg.

Il convient de noter que le procédé de cryo-dessication est le seul susceptible de s'appliquer à des produits entiers ou découpés en morceaux assez volumineux tout en leur conservant l'aptitude de reconstitution de l'état initial.

IV) METHODES APPLICABLES DANS LES PAYS TROPICAUX

A l'heure actuelle, la déshydratation de denrées alimentaires s'effectue essentiellement au soleil. La qualité des produits obtenus n'est pas toujours homogène et même satisfaisante : c'est ainsi qu'on reproche souvent aux cossettes de tomates séchées de noircir les sauces. Indépendamment de la question de la préparation de la denrée fraîche et de la conservation du produit déshydraté, une amélioration de la production peut être recherchée,

- soit en dirigeant mieux le séchage au soleil, c'est-à-dire en alternant notamment séchage au soleil et séchage à l'ombre, en triant et prolongeant le séchage pour les produits insuffisamment secs, en laissant s'homogénéiser après traitement la teneur en humidité du produit après l'avoir rassemblé dans des cases d'assez grande capacité.
- soit en installant des équipements devant assurer la totalité ou simplement un complément de déshydratation.

Le choix de l'appareillage est à faire en fonction d'une part des conditions particulières à ces pays, d'autre part des objectifs à atteindre.

En ce qui concerne les conditions d'emploi, il convient de tenir compte des facteurs suivants :

- Hormis quelques points privilégiés, la production d'énergie est onéreuse.
- La main-d'oeuvre qualifiée est rare. Par contre, durant la période hors-culture, la main-d'oeuvre rurale est nombreuse et très sous-employée.
- Les produits à déshydrater sont récoltés le plus souvent d'une façon sporadique, en des lieux éloignés les uns des autres et les tonnages pouvant ainsi être rassemblés sont modestes.
- Les conditions climatiques ne sont pas favorables à l'utilisation du froid.
- La conservation du produit déshydraté sous régime de température réduite est onéreuse et difficile à mettre en pratique du moins dans les conditions actuelles. C'est à des températures nettement supérieures à celles existant dans les entrepôts des pays tempérés (30-35° C au lieu de 15 à 18° C) que le stockage pourra se trouver effectué. Les études faites montrent que dans ce cas, pour assurer une conservation satisfaisante, encore que plus courte qu'en zone tempérée, la teneur en eau finale doit être moindre, en moyenne dans le rapport de 1 à 2. C'est d'ailleurs ce besoin de pousser davantage la déshydratation qui peut conduire à créer des ateliers ou usines de déshydratation. Compte tenu de ce besoin et de la récolte sporadique des produits frais, on peut concevoir un traitement en deux temps ; déshydratation naturelle sur les lieux de production, suivie, en un point judicieusement choisi pour assurer une collecte aisée des produits semi-secs, d'une déshydratation artificielle poussée.

En ce qui concerne les objectifs à atteindre il y a lieu de se rappeler que :

- De la nature et la valeur du produit à traiter découle toujours une limite pour le prix de revient du traitement qui peut d'autant moins être franchie que les denrées considérées ne sont pas particulièrement indispensables
- Pour les produits d'usage traditionnel, la rentabilité d'un équipement artisanal ou industriel ne peut s'asseoir que sur une amélioration de la qualité. Cette dernière peut conduire d'ailleurs à proposer sur le marché intérieur un produit nouveau mais dans ce cas le prix devra être acceptable pour le consommateur local et concurrentiel du même produit fabriqué en d'autres pays (cossettes et concentrés de tomates).

- Les débouchés sur les marchés intérieurs sont le plus souvent limités, mais, par contre, peuvent s'accomoder assez bien d'une qualité moyenne. Dans le cas où doivent être touchés les marchés des pays voisins ou à fortiori ceux des pays européens ou américains (cas de l'oignon par exemple), le problème de la qualité du produit fabriqué et de sa conservation revêt une grande importance.

Compte tenu de ces différentes observations, l'on peut dire que d'une façon générale le choix du matériel aura à s'effectuer en faveur d'appareils rustiques, de conduite aisée, de débit approprié et assez réduit, ne nécessitant pas un apport d'énergie élevé, et permettant une déshydratation poussée. L'emploi d'une main-d'oeuvre relativement importante ne constituera pas un obstacle ; au contraire même, puisque les opérations de déshydratation prenant place en dehors ou en fin de période de culture principale, c'est de la main-d'oeuvre normalement inemployée ou sous-employée qui pourra être recrutée ainsi d'une façon saisonnière. Dans ces conditions, les séchoirs à cases ou les séchoirs-tunnels paraissent donc les plus appropriés.

Ce n'est que dans le cas de traitement de produits de grande valeur ou devant donner lieu à commercialisation sur le marché mondial que pourront être envisagées des méthodes d'une technicité et de prix de revient plus élevés.

V) PREPARATION ET CONSERVATION DES PRODUITS

C'est davantage dans la voie d'une amélioration de la préparation des denrées fraîches et de la conservation des produits déshydratés que dans celle de l'installation d'équipements complexes que devraient s'engager toute application de la déshydratation de denrées alimentaires en pays de zone tropicale sèche.

Sans parler de la recherche puis de la mise en culture sur des superficies notables des variétés les plus appropriées à cette transformation, il convient de recommander d'effectuer préalablement à la déshydratation une série d'opérations, qui sont loin encore d'être pratiquées et qui ne peuvent que conduire à une amélioration sensible de la qualité des produits.

Lorsqu'il s'agit de légumes ou de fruits, les produits doivent, dès la récolte, être triés, lavés, les parties inutilisables enlevées, éventuellement pelés, découpés en tranches, cubes, lamelles, etc ... blanchis à l'eau chaude ou trempés dans une solution de bisulfite. Seuls les oignons, comme l'ail ne seront pas blanchis, car l'arôme provient d'une action enzymatique, action qui serait détruite par le blanchiment. La répartition sur plateaux de séchage doit être la plus homogène possible. Ces diverses opérations, dans la mesure où peut être utilisée une main-d'oeuvre suffisamment nombreuse, peuvent être réalisées avec des équipements très simples.

La préparation de la viande peut revêtir des aspects divers selon l'objectif poursuivi. En effet pour l'autoconsommation, la viande peut simplement être découpée en lanières peu épaisses. En vue d'une commercialisation plus étendue, la viande après désossage et dégraissage subira une précuisson dont le but est de détruire les micro-organismes non sporulés et rendre inactives les enzymes ; puis elle sera hachée et finalement déshydratée en séchoirs à tambours ou tunnels. L'application de procédés plus complexes (cryo-dessication A.F.D. ou déshydratation sous vide de morceaux congelés immergés dans de la graisse fondue) peut permettre d'éviter le hachage de la viande.

En ce qui concerne le poisson, le séchage et le fumage pourraient ne porter que sur les filets, ce qui réduirait le poids à transporter, améliorerait la présentation et permettrait un traitement plus rapide ce qui ne peut être que favorable à une meilleure conservation.

Le problème de la conservation des produits déshydratés revêt une importance fondamentale particulièrement lorsque, dans le cadre d'échanges commerciaux, se trouvent modifiées les conditions de stockage notamment l'humidité de l'atmosphère. En effet les produits déshydratés sont très hygroscopiques et il convient donc de les conditionner en emballages imperméables à l'humidité. En outre pour bon nombre de produits la présence d'oxygène et l'exposition à la lumière les déprécient à la longue par rancissement des matières grasses ou modification de la couleur. Le conditionnement pourrait se faire en boîtes métalliques, mais n'étant pas produites sur place, ces dernières sont d'un prix de revient prohibitif. Au contraire la mise des denrées en sachets de matière plastique imperméable à l'humidité, avant désaération avant soudure ou emballage sous gaz inerte (azote), constitue une méthode pouvant être mise en oeuvre beaucoup plus aisément. Les sachets qui sont transparents ou translucides sont à leur tour mis dans des emballages de carton opaque qui les protègent contre la lumière et aussi contre les chocs dûs aux divers transports et manutentions.

Le stockage des produits doit s'effectuer dans des locaux bien abrités, sains et à la température la plus basse possible. La durée de conservation sera d'autant plus longue que cette dernière condition sera mieux remplie.

VI) CONCLUSIONS

La déshydratation de denrées alimentaires présente trop d'avantages en pays de la zone tropicale sèche pour que n'en soit pas recherchée une meilleure application. Déjà et depuis longtemps, certains produits sont ainsi préparés, mais nous avons vu que leur qualité ainsi que leurs conditions de conservation devaient et pouvaient être améliorées.

Cette méthode peut recevoir également de nouvelles applications : produits de l'élevage, viande en particulier, dont la commercialisation peut revêtir un nouvel aspect, pommes de terre locales, dont la conservation est actuellement si mauvaise.

La déshydratation s'enrichit d'une façon permanente de nouvelles découvertes; les pays tropicaux de climat sec devraient constituer un terrain d'application de choix car beaucoup de facteurs y militent plus en faveur de cette méthode de conservation que d'autres techniques qui ont pu connaître de grands développements ailleurs, et la gamme des procédés désormais disponibles est suffisamment étendue pour que soit toujours choisi l'équipement le plus approprié aux conditions économiques.

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ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item : D.4.1

France

DEHYDRATION OF FOODSTUFFS IN COUNTRIES OF THE TROPICAL ZONE (AFRICA)

By M.B. ROUGE,
Engineer of the Génie Rural,
Central Technical Section of Agricultural
and Food-producing Industries

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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DEHYDRATION OF FOODSTUFFS IN COUNTRIES OF THE TROPICAL ZONE

By
M.B. ROUGE, ENGINEER OF THE GENIE RURAL, CENTRAL TECHNICAL SECTION OF AGRICULTURAL AND FOOD INDUSTRIES.

Dehydration as a method of preservation is first defined and located amongst the other methods of preservation of perishable foodstuffs.

Then attention is drawn to the advantages which this method can offer in the case of countries in the dry tropical zone:

- the climate, by virtue of its usually low hygrometric factor, lends itself naturally to the application of the method; on the other hand the high temperature does not favour employment of the current method of preservation of fresh foodstuffs by refrigeration.

- the great transport distances involved, and inadequate stocking facilities, favour the use of products of reduced volume.

- the use of dehydrated foodstuffs is well adapted to the traditional equipment of the local consumer.

There follows a brief summary of the methods and apparatus of dehydration with their respective principal advantages and disadvantages. The processes are divided into four categories:

- those in which heat is used, either directly or through the medium of air or a gas.

- those in which the action of heat is added to that of a vacuum;

- those in which the action of dry air is used

- those in which dehydration is combined with the action of cold.

A choice must be made between these processes in the light of the particular conditions obtaining in these countries; namely:

- production of power difficult;

- skilled labour rare, but availability, outside periods of cultivation, of a large rural labour force;

- necessity for rapid dehydration to ensure adequate preservation of the product;

- outlets for goods thus produced in usually restricted markets;

- competition in the case of certain imported goods.

Real progress can be made in the preparation of foodstuffs to be dehydrated and especially in conditioning with a view to their preservation.

The field of application of dehydration, already practised in countries of the dry tropical zone, should be capable of considerable extension in the light of the favourable conditions obtaining there.

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Agenda Item: D.10

United Kingdom

ENGINEERING PRODUCTION

By Dr. N.A. DUDLEY,
Lucas Professor of Engineering Production,
University of Birmingham.

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No. 2027
D.10

D. 10. Engineering Production

Dr. N.A. Dudley,
Lucas Professor of Engineering Production,
University of Birmingham.

1. Industrial advance is usually assessed in terms of technical development and of the rate of application of new and improved techniques; in terms of, for example, the adoption of automatic self-correcting devices for controlling manufacturing processes, or of high-speed automatic data-processing equipment and the introduction of new materials and larger and faster machine tools. From time to time, comparative studies are made of the increasing ratio of horse-power to man-power employed in production, or of the numbers of electronic computers installed in different industries. Studies are also made of the time-lag between the emergence of new techniques or processes from the research laboratory, and their general acceptance and routine application in the factory. Agencies are set up by government departments and by research and other associations to disseminate information about these innovations, and to encourage and accelerate their adoption when the time-lag appears excessive.

2. While such developments increase the potentialities for increased production, however, it by no means follows that their adoption automatically or inevitably leads to an increased total volume of production from the factories in which they are installed, nor that what is produced is produced more economically. This is as true of the more highly developed industries as it is of the less highly developed, for, whatever the level of technical development, there is always scope for more effective Engineering Production.

3. Engineering Production is concerned primarily with the planning, organising and control of manufacturing industry. It is a study embracing all aspects of production - technical, human, economic- and has been developed to meet the need for more efficient production. Its emergence as a unified science and technology-

now recognised at the highest academic levels - is mainly due to the considerable research effort which has been directed, in recent years, to the discovery and understanding of the nature, characteristics and interaction of the various agents of production, and of the principles upon which the planning, co-ordination and control of industrial production should be based.

4. Much attention is being directed to an understanding of industrial skills, to the characteristic behaviour of machine tool and other processes and particularly to man-machine control systems. The attainment of technical perfection of the tools of production and of their competent operation, however, is but one stage in efficient and economic engineering production. If the output of individual machines and processes and of workers were infinitely adjustable, and if the desired volume and quality of output at any moment were those which could be produced at minimum cost per unit, production planning would present no serious problem. In fact, because of the different output rates of production processes, there is a tendency for work to pile up between certain machines and for certain other machines and workers to be kept waiting. Superimposed on the inherent differences in capacity and quality of output of new machines are the effects of age and use and misuse. Machines have to be serviced and they have to be maintained. Their capital cost and running cost varies, as does the cost of raw materials and of labour and the demand for the finished products.

5. Preparation of the simplest production plan involves (or, rather, should involve) consideration of many variables, and research is being undertaken so that - in determining optimum production strategy - scientific evaluation of the situation may supplant trial and error and supplement experience. The investigations, aimed at promoting more efficient planning of production, are of two kinds: those concerned with advancing knowledge of the characteristics of the available tools or agents of production and of their interaction, and those concerned with developing techniques by the use of which inefficiencies may be illuminated and the most effective means of attaining specific production objectives identified.

6. The need - even in highly developed industries - for research aimed at securing a better understanding of the tools of production arises mainly from the preoccupation of most machine designers with the technicalities of the individual piece of equipment. While much is known about the immediate performance of new machine tools and other equipment at the time of their construction and installation, little is known, as yet, about the rate of wear of machines and the effect of wear on tolerances, on the quality and quantity of output and, not least, on the patience of the operator. This knowledge is of paramount interest and importance to the production engineer. In much the same way, little is known about the physical and mental capacity of workers, and of the limitations imposed by age, health, working conditions and so on, although some progress has been made in dimensioning variations in performance of semi-skilled workers on repetitive tasks, both when they are free to work at their own speed and when they are paced by a conveyor belt, machine or other workers.

7. While there has been a tendency to concentrate on developing and refining "productivity improvement" techniques to perfect the more advanced and highly developed industries, considerable improvements in productivity may be effected by the use of less sophisticated techniques in small scale and under developed industries. The techniques - of universal application-range from elementary method study and process planning to ergonomics studies in which physiological and psychological factors are weighed against technical requirements and economic restrictions, and to the systematic analysis of complete manufacturing systems by use of the more rigorous tools of operational research.

8. The primary work analysis and methods improvement techniques - capable of more or less routine application - could undoubtedly be of immense benefit to the less developed areas, for, while the relatively high cost of labour and of labour disputes in highly developed and highly organised industries gives impetus to the drive towards automatic production, the relative abundance of labour in under developed countries indicates that increased productivity should be sought mainly by way of more effective utilisation of labour and of such capital resources as are available, or as can appropriately be made available.

9. There are countless examples of rapid improvements of production efficiency - of marked reductions in production time and cost - that have been achieved by the application of relatively simple techniques of work analysis and measurement and a critical and searching examination of methods of working, of procedures and of layout of factory departments. Such improvements, resulting from the elimination of unnecessary or unnecessarily fatiguing or time-consuming activities and, as far as possible, of idle time, have seldom involved any appreciable capital expenditure but they have always resulted from an active collaboration of management and workers. Such collaboration is seldom difficult to establish once it is made clear that more effective work does not necessarily mean more arduous work and assurances are given that all concerned will benefit from the increased productivity.

10. In the field of production planning and control, many of the refined techniques of analysis and measurement that are now being developed and applied in the most advanced industrial countries, are also immediately applicable in the under developed countries, though perhaps not always in precisely the same way, for there is little point in employing these more powerful tools where relatively simple and routine techniques can make a major impact. Although the less developed areas have many obvious disadvantages in some respects, they have decided advantages in others. For example, an industrial company in the United Kingdom, or in the United States, might employ linear programming to determine where depots or warehouses should be located , or should have been located, and the optimum size of such depots under given circumstances. In less developed countries, major decisions on location and size of facilities, affecting not merely one particular company, but entire industries, and indeed the whole community, could be readily made, and with far fewer restrictions or constraints than are commonly encountered in the more highly developed industries. Other associated mathematical and statistically-based techniques developed in recent years under the label operational research or operations research, can enable major and long-term policy decisions to be determined on a scientific, or at any rate, quantitative basis, and in accordance with an overall industrial or community plan. Problems relating to allocation of resources, product targets and inventory levels, problems concerned with determining optimum operating conditions, the conditions under which production cost may be minimised, or profits maximised, may be solved by these means.

11. The sponsoring, by the governments of under-developed countries and by various international agencies, of young scientists , mathematicians and engineers on postgraduate courses of study in operational research in the United Kingdom and in the U.S.A. and elsewhere, is recognition of the service that the operational research approach can render in the quest for more efficient engineering production.

12. In recent years, research into the organisation of batch production industries - that is, the type of production likely to be typical in less developed countries within the forseeable future - has revealed many characteristic features and problems of which industrial managers should be aware when seeking to improve existing industries or when planning and developing new ones. For many years, much effort has been given to developing methods of determining economic batch sizes, in the assessment of which the capital tied up in work-in-progress and the cost of delays, (involved when products or components must wait for the rest of the batch to be processed,) are weighed against the time and cost of setting up machines and changing over tools and other equipment to suit a succession of batches of different components. The more recent researches, however, have revealed that these delays, inherent in batch production, are a mere fraction of the total delays associated with and commonly found in this type of manufacture.

13. Much time is lost in, for example, transporting materials from the raw material stores to work stations, between work stations and on to the despatch department, simply because of the nature of the organisation commonly found in batch production industry. In so far as it is a technical matter - a question of layout of factories and arrangement of processes - the problems and the principles underlying their solutions are universal. Bearing in mind, however, that many of the problems or causes of delay - and certainly the most critical - are of a psychological or sociological nature, it would appear that similar researches must be carried out in the conditions actually obtaining within less developed areas. An additional and compelling reason for repeating such studies is, of course, the impact on productive efficiency of climate, of local traditions and customs and of terms of employment prevailing in those areas.

14. It may be found in those areas - as in the case of more highly developed industry - that work is not transferred as speedily as it might be from one section to another merely because, in batch production factories, manufacturing departments or sections tend to become self- contained, concerned exclusively with a particular production process. Often there is no clear definition of duties and responsibilities for those concerned with the actual movement of materials from one section to another. It may be that the head of a section is preoccupied only with securing an adequate supply of material for his group of workers, and has no incentive to transfer finished work speedily to the next section. It may be found here, too, that a factory manager allows finished work to accumulate simply because his director is agreeably impressed by the sight of a large stack of finished work. It may be that here, also, the psychological effect of the amount of work presented to a worker on the worker's performance is of greater significance than any economic justification or determinant of batch size.

15. At the level of the manufacturing process itself, it is clear - particularly in the light of what has already been said - that local conditions must determine the desirable degree of mechanisation. In general, this will fall short of completely automatic production. In some of the largest and most efficient mass production factories, large numbers of workers are employed on assembly and other operations, (even though the work could be readily mechanised) merely because it is more economical to the companies for workers to be so employed. This must surely be the case, also, in the less developed areas, where there is a more plentiful supply of labour which can be trained for repetitive work of this kind. What is of paramount importance, however, is that individual production processes should be carefully method-studied with due regard, not merely to mechanical efficiency, but also to ease and simplicity of operation. Since the type of machine tools and other basic manufacturing equipment likely to be increasingly in demand in the less developed areas is the standard and general purpose variety, and since such machines are usually of fairly simple design and construction, their production can, with advantage, be encouraged in those areas. It would be unfortunate, however, if imported designs were slavishly reproduced and without due regard to the data that are to hand, and should be made available, on the design and location of manual controls.

16. In highly developed industry, lip service is paid to scientific worker selection, but under conditions of near full employment, it is impracticable, if not impossible, to carry vocational selection as far as one would wish. In the less developed areas, however, there appears to be unlimited scope for careful and systematic guidance, selection and initiation of workers as well as for specialised operative training as now practised in the most advanced industries.

17. Trends towards automatic production in the most advanced large scale industries are sometimes hindered by the fact that, for certain kinds of work, including some so-called semi-skilled work, the skills and special abilities of the operator seem indispensable and irreplaceable; A number of researches are being pursued in the United Kingdom, with Government support, to determine the nature of certain of those industrial skills, and in particular those used in the control of various kinds of machine. One example of this - in the mass production of motor cars - is the sensitive drilling of small diameter holes in certain components, another - in a tube mill - is the manual slitting of drawn tubes. The immediate objective of such researches is to identify and dimension the signals from which the operator derives the information on which he acts, and to determine the precise nature of the response which he makes.

18. The outcome of such research might be, either to enable the manual controls of machines to be improved so that they may be more easily, more speedily or more accurately manipulated or to enable the workers' skill to be simulated in the design of automatic controls. It is perhaps looking some way into the future to foresee the need for similar researches in the less developed areas. Being aware, however, of how great sometimes are differences in performance of workers within a particular industry or factory, there would be an obvious danger in attempting to translate the findings of such researches from a more highly to a less highly developed community, and thus, sooner or later, fundamental and applied research of this kind will need to be pursued in the less developed areas.

19. On the other hand, comparative studies of production planning, organising and control activities in different industries within a given community, reveal many common characteristics. For example, the advantages of the division of labour, with its resultant specialisation and increased efficiency of performance, have long been acknowledged and noted as a key factor in industrial development, so that the manufacture of many products now involves a long series of individual and discrete production processes of comparatively short duration. As long ago as Adam Smith, the contribution of this division of labour to increased productivity was being recognised, and quite recently experimenters have been concerned with the probable and conjectured physiological and psychological effects of such monotonous and repetitive work. Not until the current studies of batch production, however, has it been observed that the range of times to process a batch, increases directly with every additional process to be performed. This is as true of the manufacture of boots and shoes as it is of the manufacture of machine tools. There is much to be learned on such matters in both the more developed and the less developed areas. What the more advanced students of engineering production have to offer, are research techniques which will enable a better understanding of the characteristics of different types of production to be achieved, and thus enable production to be more effectively planned and controlled.

20. One of the most striking causes of increased productivity has been the growing acceptance of the principles of specialization and standardization. Small scale jobbing and batch production factories have been enabled to share some of the advantages of large scale production by standardising product components or component features wherever possible. For example, the manufacturer of an extensive range of small internal combustion engines - with orders ranging from two or three to twenty of any particular type - has found it possible to satisfy the needs of all types of engine with only two sizes of piston. To be effective, efforts of this kind demand not only determination and patience, but the ability to plan and introduce an investigation procedure in which the work of designers, development, production and methods engineers and market research specialists is smoothly integrated.

21. It was a weakness of even the highly industrialised areas not so long ago that the need for a distinct engineering function charged with the effective integration of all aspects of

production was not always recognised. It is still a weakness in some quarters that the nature of this function is conceived too narrowly. High technical efficiency is not always synonymous with high overall productivity. We speak of the increased productivity of a new piece of manufacturing equipment, but what really matters is the impact of this machine on the entire production unit in which it is installed. A technically less advanced machine may be better integrated into the production flow; indeed the term production flow seems to have no real meaning in many otherwise technically advanced companies. In other words, there has been no really systematic attempt to ensure that production does flow smoothly and effectively. The techniques needed are, for the most part, relatively simple. Where they are not - as for example, in certain applications of queueing theory - they do not necessarily involve great capital expenditure. It would seem, therefore, that in the efficient use of such resources as are available the less developed areas could be brought up to the level of, if not surpass, the performance of the many so-called highly developed areas. The rapid development of Engineering Production studies is a measure of its contribution to productive efficiency. (It is but 14 years since Engineering Production was introduced into a British university as a subject for postgraduate study, and the first professor appointed. Within the last 12 months, the first B.Sc. degree course has been approved, and the International Journal of Production Research launched, under the sponsorship of the British Institution of Production Engineers.) There is already conclusive evidence that science and technology of Engineering Production are of universal application.

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SUMMARY

Agenda Item: D.10

United Kingdom

ENGINEERING PRODUCTION

By Dr. N.A. DUDLEY,
Lucas Professor of Engineering Production,
University of Birmingham

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D.10.

D. 10. Engineering Production

Dr. N.A. Dudley,
Lucas Professor of Engineering Production,
University of Birmingham.

S U M M A R Y

Engineering Production is concerned with the planning, organising and control of manufacturing industry. It is a study embracing all aspects of production - technical, human and economic - and its emergence as a unified science and technology is mainly due to the considerable research effort in this field in recent years. This research has been directed in part to an understanding of the nature, characteristics and interaction of the various agents of production and of the principles upon which the planning, co-ordination and control of production should be based, and in part to the development of a range of productivity improvement techniques.

While there has been a tendency to concentrate on developing and refining techniques to perfect the more advanced and highly developed industries, considerable improvements in productivity may be effected by the use of less sophisticated techniques in small-scale and under developed industries. There is conclusive evidence that the science and technology of Engineering Production are of universal application.

The techniques employed range from elementary method study and process planning to ergonomics studies, in which physiological and psychological factors are weighed against technical requirements and economic restrictions, and to the systematic analysis of complete manufacturing systems by use of the more rigorous tools of operational research.

Although industrial advance is usually assessed in terms of technical development, it by no means follows that such development automatically leads to increased production or productivity. Nor is the organisation approaching complete automation necessarily the most efficient. On the contrary, more efficient use of labour - more effectively trained - with a modest level of mechanisation, can substantially raise the level of productivity in the less developed areas, provided the overall production strategy has been scientifically determined.

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Agenda Item : D.4.2

Canada

FOOD PRESERVATION BY LOW DOSE GAMMA IRRADIATION

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FOOD PRESERVATION BY LOW DOSE GAMMA IRRADIATION

by
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Commercial Product Division
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Ottawa, Canada

1. (a) Food preservation by gamma irradiation appears to have promise as a method of increasing food supplies in areas of the world where shortages exist and where climate and storage conditions contribute to excessive spoilage. It should also be valuable in extending shelf life of fresh products to permit marketing over a longer period and at greater distance from the production area.

(b) The amount of experimental work and the number of groups carrying on tests have increased substantially over the past some years. In our own case, and perhaps also in the case of others in the field, there has been a definite tendency to concentrate on specific products. This indicates that we feel that certain applications are closer to commercial realization than others.

(c) The Canadian program envisages three stages of accomplishment: initial scientific tests on small quantities, combined with observation of side effects; pilot plant tests at production or processing locations; and full scale processing on a commercial basis. Not all products under consideration will go through these stages at the same time.

(d) During the program of tests, information is accumulated from our own work and from the published works of others. This is used to prepare a submission to the Canadian Food and Drug Directorate by way of a recommendation that particular products be sold for human consumption. Up to now we have submitted only two such proposals covering potatoes and onions.

(e) The objective of food preservation by gamma radiation is, of course, to conserve the quantity or quality of the product. This method of conservation must be related to other ways of accomplishing a similar result and to the economics of the process. The factors to be considered within the above general objective will vary widely from one country to another and between areas in the same country.

(f) The dosage of gamma radiation required to accomplish food preservation depends upon the product and the type of change which should be produced. It varies over a broad range, from simple sprout inhibition of potatoes or onions at a few thousand rads to pasteurization or sterilization at dosages up to millions of rads. This presentation will consider only products which can be treated at the pasteurization level of dosage or lower.

(g) Based on the work done in Canada and elsewhere, a number of agricultural products appear amenable to treatment with gamma radiation.

(i) Commercial sprout inhibition of potatoes, onions, carrots, and garlic appears promising. Dose requirements are low at about 8,000 rads.

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(ii) The treatment of pork with doses of 20,000 to 30,000 rads removes the hazard of trichinosis. Technical feasibility has been established and commercial application may be imminent.

(iii) Doses of 20,000 to 50,000 rads will prevent reproduction of insects in stored cereal crops. Such treatment, combined with good storage conditions, should reduce the serious losses of food products which may occur, particularly in warm and tropical countries.

(iv) Radiation at the pasteurization level also holds much promise. The control of molds in strawberries and citrus fruits, brown rot in peaches, and delay in ripening of bananas, are examples of promising applications. Our experiments indicate that a dose of 85,000 rads will reduce the incidence of coreflush and scald in apples, and a dose of 200,000 rads extends the fresh shelf life of strawberries by several weeks when stored at 40°F following treatment. Dose levels from 100,000 to 600,000 rads have been used to extend the refrigerated shelf life of sea foods, such as cod, haddock, crabmeat, oysters, and shrimp. A program to study the preservation of scallops by radiation treatment is currently underway in Canada.

(v) Early commercial application of radiation treatment of poultry and egg products is anticipated. Salmonella organisms in frozen eggs can be destroyed at dosages of 300,000 to 500,000 rads.

2. (a) The time allocated to this paper precludes detailed examination of the work done on all products. I have therefore chosen to examine a specific case, namely, inhibition of sprouting of fresh vegetables and particularly potatoes. Over a period of years, many investigators have irradiated laboratory quantities of potatoes and observed the very favourable control of sprouting. The background for field tests, therefore, had been well prepared.

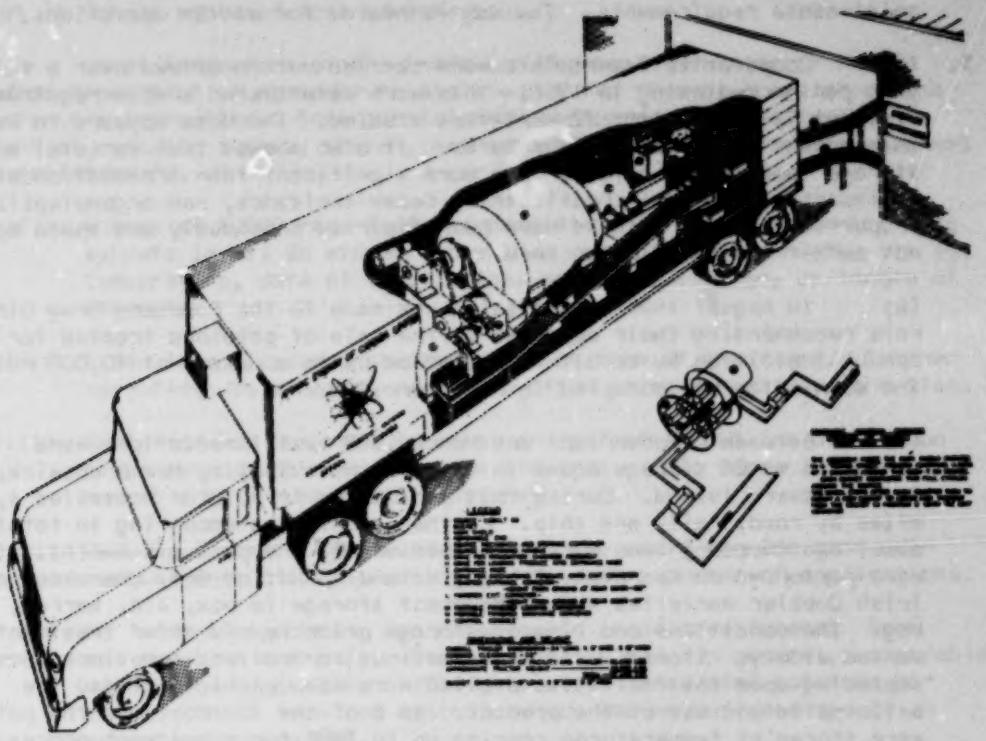
(b) In 1961 we designed and produced a Mobile Demonstration Irradiator. Massive tests of pilot plant quantities were performed in the fall of 1961 and again in 1962. It was and is our opinion that this work had to be taken closer to the producer, warehouse operator and processor so that the results could be observed locally on quantity lots. The MDI was not intended to operate at a volume which would permit satisfactory economics. Weight limitations made it necessary to use lead as a shielding material, thus increasing costs of fabrication compared with the use of concrete if a fixed irradiator had been used. In addition, we wished to use the MDI for experimental work on a variety of products. Consequently its design was considerably more complicated than would otherwise be necessary.

(c) The irradiator is mounted on a standard trailer 8' x 12' x 34' capable of highway transport. Details are as follows:

Source - Cobalt-60 sealed in double walled, double welded stainless steel capsules.

Shielding Capacity - 25,000 curies.

Shielding Material - 10" of lead in steel.



Mobile Demonstration Irradiator

Weight - Machine 65,000 lbs.
- Trailer 15,000 lbs.
- Tractor 12,000 lbs.

Throughput at 15,000 curies - 2,500 lbs. per hr. to a dose of 7,500 rads.

Dose Uniformity - ±15%.

Bucket Size - 8" x 8" x 15".

Exposure Time - Variable (3 minutes total for potatoes).

The type of construction is shown in Figure 1.

(d) As shown in the illustration, buckets are received on a conveyor, pass through the irradiation chamber, and are discharged on a separate conveyor at the same end of the van. Eight bucket positions are provided within the irradiation chamber, four each on two ferris wheel mountings. Each bucket therefore makes two complete revolutions around the rod style source, remaining upright at all times. This arrangement provides for relatively uniform dosage to all produce in the bucket. Control of the operation is accomplished simply from the console at the rear.

(e) The irradiator operated well in all types of weather, with minimum maintenance requirements. The van is heated for winter operations.

3. (a) Cooperative experiments were carried out in Ottawa over a three year period beginning in 1956. This work established a dose requirement of about 7,000 rads for 12 varieties studied. The dose appears to be independent of storage temperatures. It also showed that varietal and storage temperature effects were more significant than irradiation effects on important chemical constituents, decay incidence, and organoleptic properties. These results have been reported previously and space does not permit their inclusion here.

(b) In August 1960 a submission was made to the Food and Drug Directorate recommending their approval of the sale of potatoes treated for sprout inhibition by cobalt-60 radiation up to a dosage of 10,000 rads. The submission was accepted in November 1960.

(c) Between October 1961 and March 1962 test irradiations were performed at 26 storage areas in Ontario, Nova Scotia, New Brunswick, and Prince Edward Island. During this period the irradiator travelled 4,000 miles by road, rail, and ship. Further quantities amounting in total to about one thousand tons were processed during the past six months. Tests were performed on Kennebec, Sebago, Katahdin, Netted Gem, Cherokee, and Irish Cobbler varieties with subsequent storage in box, bin, barrel, and bag. The conditions and time of storage prior to and after treatment varied widely. Storage used was sometimes controlled, sometimes common, depending upon the facilities available to each participant and the anticipated end use of the product. In 8 of the 26 locations the potatoes were stored at temperatures ranging up to 70°F for subsequent processing. Potatoes in the other 18 locations were maintained in unheated storage for table stock use. The table below illustrates that irradiation is a completely effective sprout inhibitor even at high temperature storage.

Sprouting in Kennebec potatoes

		Sprouting			
		Control		Irradiated	
Month	Storage Temperature	Percentage	Length	Percentage	Length
November	60°F	10	Visible only	nil	nil
December	60	90	3/4" to 1-1/2"	"	"
January	60	100	3" to 6"	"	"
February	58	100	6" to 8"	"	"
March	58	100	10" to 24"	"	"
April	70	Total loss		"	"
May	70	"	"	"	"
June	80	"	"	"	"

From February onward all control tubers were soft. In March control tubers had shown considerable wilting and were shrivelled.

Participants in the program provided the potatoes and subsequently stored them alongside untreated controls under identical conditions. The potatoes remained the property of participants who were at liberty to sell them (after allowing for a sufficient time of observation) in whatever

market in Canada appeared most advantageous.

(d) Local inspectors of the Fruit and Vegetable Division of the Canadian Department of Agriculture assisted at the time of irradiation and at intervals thereafter. Some participants performed detailed tests on content of reducing sugars, starch, and ascorbic acid. The results observed were satisfactory.

4. (a) (i) A dose of 8,000 rads ±13% was completely effective in controlling sprouts in all 26 storage locations regardless of variety, storage temperature, date of irradiation. method of storage, or length of storage.

(ii) A few lots displayed short sprouts at time of treatment. Further sprouting was stopped and growth of existing sprouts was arrested.

(iii) Radiation was observed to be a more potent sprout inhibitor than other methods used in the same storages. This comparison was possible at a number of locations.

(iv) Results indicate that even a lower dose would provide good commercial control of sprouting in at least a number of applications.

(v) No internal sprouting was observed in irradiated tubers. Some was found in controls. Storage quality was, in general, comparable with original quality of the potatoes. Irradiated potatoes remained firmer than the controls which became soft and spongy as sprouting progressed.

(vi) A few trials exhibited poor storage quality. All of these occurred in one locality which may be a reflection of the general harvest and storage conditions. In that locality the growing season was extremely wet with the result that spraying for blight was not carried out properly.

(vii) The most common defect found in both control and irradiated potatoes was dry rot which developed from mechanical or other injury. This indicates the need for careful handling during processing. These two problems will be further investigated in trials during the fall of 1962 and winter of 1963. Processing on a full scale basis would simplify handling since it would not be necessary to use such small buckets. It is anticipated that this will correct the problem of dry rot.

(viii) Carefully handled potatoes treated promptly following digging, and without curing, stored particularly well.

(ix) Observations made in a retail market and in a separate experiment showed that irradiated potatoes are more resistant to light greening than unirradiated tubers.

(x) Irradiated potatoes were successfully processed into chips, instant mashed flakes, frozen french fries, and fresh boilers. The irradiation did not affect the quality.

(xi) Reducing sugar level differences among varieties were found to be more significant than between control and irradiated tubers of the same variety.

(xii) No complaints of any kind were received or reported regarding consumer acceptability of irradiated potatoes. Legislation in Canada does not require that the potatoes be labelled "irradiated" nor does it require that potatoes treated with other sprout inhibitors be so labelled.

(b) The program provided a good deal of new information for us and for the other participants. I am sure that it placed the possibilities in much better focus for the potato growers and processors. The results have created a favourable climate for commercial potato irradiation. Our program, related to Canadian conditions, has:

(i) Confirmed the desirability of pilot plant tests;

(ii) Provided the industry with an opportunity to evaluate the process in terms of their own conditions;

(iii) Ascertained consumer acceptability;

(iv) Assisted in educating industry and the public by the cooperative nature of the work.

5. (a) In view of the very favourable results on experimental and pilot run quantities, the matter of commercialization of the program is now reduced to its simplest terms - economics. Good economy can only be achieved by volume processing in a well designed and efficiently operated, full size irradiator.

(b) Although some standardization of design will be essential, we anticipate that different countries and different localities within the same country will require different machines for full scale quantity processing. Some variations in machine design will also be required, depending upon the type of storage and handling facilities available to the processor and upon the volume of product which can conveniently be processed in one location.

(c) Simplicity should be possible in all design variations thus making professional help unnecessary. This will be important particularly in areas where skilled technical operators are scarce.

(d) (i) The machine we envisage as suitable for most Canadian conditions would have a capacity of 100 to 200 megarad pounds per hour, representing a throughput of some 13,300 to 26,600 pounds of potatoes per hour. A source of between 60,000 and 120,000 curies of cobalt-60 would be required.

(ii) The machine would not be mobile and hence could make use of ordinary concrete or other cheap material for shielding.

(iii) The machines which we shall provide will make use of proven engineering techniques and standard components where possible. Design will be such that maintenance will be straightforward and infrequent. It is anticipated that only a semi-skilled technician will be required to operate a full scale machine.

(e) The source would be in the form of a plaque about 4' wide and somewhere between 4' and 8' long. A safe storage position is provided in a dry pit. To recharge the source, the pit would be filled with water.

(f) Produce treated would be in boxes 4' x 2' x 1'3" deep, or perhaps 4' x 4' x 1'3" deep, if more convenient to local storage. The box would enter and leave the irradiation chamber via mazes. The use of boxes is preferred because they provide uniformity, reduce damage to produce, enable a machine to be used for a variety of produce, and present some simplicity in the conveyor and handling systems.

(g) For lower throughputs - 20 to 30 megarad pounds per hour - even simpler preliminary designs are available.

(h) Based on measurements made on a model of a full size unit, radiation utilization efficiency is expected to be between 15 and 25% depending on special design features and throughput required.

(i) Machines for use in areas where labour is plentiful and relatively inexpensive will likely require fewer automatic features for loading and unloading of produce boxes.

6. (a) An exact estimate of processing costs cannot be made on a general basis. Costs per 100 pounds of produce throughput will depend on construction and labour cost in the area; throughput - whether the machine can be used for other products in the off season; the type of storage and handling facilities already available or to be provided; and on other considerations.

(b) Nevertheless, if we assume conditions as we know them in Canada, we estimate that a full scale radiation processing facility for potato sprout inhibition can be provided at prices which will permit total processing costs of about 15¢ per 100 pounds. This can be reduced proportionately if commercial scale processing can tolerate a dose of less than 8,000 rads.

(i) The estimate is based on a throughput of about 50 million pounds per season. A throughput of 25 million pounds per season would probably cost about 24¢ per 100 pounds. If the machine is located where reasonable quantities of, say, carrots and onions can also be processed, worthwhile savings will be realized because of the increase in the operating period during the season.

(ii) These cost estimates are based on today's commercial prices for cobalt-60 and for construction of equipment. They include provision for complete write-off of the facility in 10 years plus

interest at 6% per annum on the unpaid balance of original cost. Also included is provision for annual replenishment of the source, operating labour at $9.00 per hour, and overhead at 100% of labour.

(c) Estimates for carrots and onions to prevent sprouting are respectively a little more, and a little less, than for potatoes at similar throughputs.

(d) It appears that for seasonal operation of potato processing plants, substantial savings can be made compared with otherwise necessary importation of potatoes when prices are high.

7. (a) I mentioned earlier that the conditions which obtain in Canada are probably different from those in many other areas. This could be an advantage or a disadvantage.

(b) It seems to us that in the investigation of the treatment of food products by irradiation, in most instances field trials are important as well as laboratory tests. These can be carried out in cooperation with government and industry. Early experiments can be made using laboratory equipment capable of processing a few pounds at a time. Field tests can be done very well on a mobile unit of the type which we used. It is not recommended that pilot plant quantities be shipped to a stationary unit for testing a process. This introduces additional handling and other changes in conditions which may be significant.

(c) Cobalt irradiation facilities can be operated without any large requirements for outside power. The simplicity of design and operation permits the use of technicians rather than scientists or engineers and provides for low operating cost. This should be particularly attractive in areas where skilled personnel are scarce.

(d) The reduction of spoilage in food products will have a significance (for other than purely economic reasons) even greater in areas of high population density and low per capita production of food.

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UNITED NATIONS CONFERENCE
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FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.4.2

Canada

FOOD PRESERVATION BY LOW DOSE GAMMA IRRADIATION

By R.F. ERRINGTON, M.A.,
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Ottawa, Canada

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FOOD PRESERVATION BY LOW DOSE GAMMA IRRADIATION

by
R. P. Errington, M.A., Manager
Commercial Products Division
Atomic Energy of Canada Limited
Ottawa, Canada

Summary

(a) Food preservation by gamma irradiation appears to have promise as a method of increasing food supplies in areas of the world where shortages exist and where climate and storage conditions contribute to excessive spoilage. It should also be valuable in extending shelf life of fresh products to permit marketing over a longer period and at greater distance from the production area.

(b) The Canadian program envisages three stages of accomplishment: initial scientific tests on small quantities, combined with observation of side effects; pilot plant tests at production or processing locations; and full scale processing on a commercial basis. Not all products under consideration will go through these stages at the same time.

(c) The objective of food preservation by gamma radiation is, of course, to conserve the quantity or quality of the product. This method of conservation must be related to other ways of accomplishing a similar result and to the economics of the process. The factors to be considered within the above general objective will vary widely from one country to another and between areas in the same country.

(d) Based on the work done in Canada and elsewhere, a number of agricultural products appear amenable to treatment with gamma radiation.

(i) Commercial sprout inhibition of potatoes, onions, carrots, and garlic appears promising. Dose requirements are low at about 8,000 rads.

(ii) The treatment of pork with doses of 20,000 to 30,000 rads removes the hazard of trichinosis. Technical feasibility has been established and commercial application may be imminent.

(iii) Doses of 20,000 to 50,000 rads will prevent reproduction of insects in stored cereal crops. Such treatment, combined with good storage conditions, should reduce the serious losses of food products which may occur, particularly in warm and tropical countries.

(iv) Early commercial application of radiation treatment of poultry and egg products is anticipated. Salmonella organisms in frozen eggs can be destroyed at dosages of 300,000 to 500,000 rads.

2. (a) The time allocated to this paper precludes detailed examination of the work done on all products. I have therefore chosen to examine a specific case, namely, inhibition of sprouting of fresh vegetables and particularly potatoes.

(b) In 1961 we designed and produced a Mobile Demonstration Irradiator. Massive tests of pilot plant quantities were performed in the fall of 1961 and again in 1962.

(c) The irradiator is mounted on a standard trailer 8' x 12' x 34' capable of highway transport. Details are as follows:

Shielding - 10" of lead in steel to contain 25,000 curies cobalt-60.

Weight - Machine 65,000 lbs.; trailer 15,000 lbs.; tractor 12,000 lbs.

Throughput at 15,000 curies - 2,500 lbs. per hr. at 7,500 rads.

(d) Buckets are received on a conveyor, pass through the irradiation chamber, and are discharged on a separate conveyor at the same end of the van. Eight bucket positions are provided within the irradiation chamber, four each on two ferris wheel mountings. Each bucket therefore makes two complete revolutions around the rod style source, remaining upright at all times.

3. (a) In August 1960 a submission was made to the Food and Drug Directorate recommending their approval of the sale of potatoes treated for sprout inhibition by cobalt-60 radiation up to a dosage of 10,000 rads. The submission was accepted in November 1960.

(b) Between October 1961 and March 1962 test irradiations were performed at 26 storage areas in Ontario, Nova Scotia, New Brunswick and Prince Edward Island. Tests were performed on Kennebec, Sebago, Katahdin, Netted Gem, Cherokee, and Irish Cobbler varieties with subsequent storage in box, bin, barrel, and bag. The conditions and time of storage prior to and after treatment varied widely. In 8 of the 26 locations the potatoes were stored at temperatures ranging up to 70°F for subsequent processing.

4. (a) Completely effective sprout inhibition was obtained in all cases. Radiation treatment was observed to be more effective than other methods. A lower dosage level would probably be satisfactory on a commercial basis. There was no internal sprouting and irradiated potatoes remained firmer than controls. Some dry rot was present in both control and treated potatoes. Irradiated potatoes were found to be more resistant to light greening. The quality of chips, instant mashed flakes, frozen french fries, and fresh boilers produced from irradiated potatoes was found to be good.

5. (a) The favourable results make commercialization of the process imminent. Low cost can only be obtained with volume throughput. We envisage a full scale irradiator suitable for Canadian conditions with a throughput of some 13,300 to 26,600 pounds per hour. This will require a cobalt-60 source of 60,000 to 120,000 curies. The machine would not be mobile and would be operated by semi-skilled technicians only.

6. (a) The simplicity of design and operation of anticipated full size irradiators should make them particularly attractive in areas where skilled personnel are scarce. The reduction of spoilage in food products will be important in areas of high population density and low per capita production.

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Agenda Item: D.5.1

Japan

PRODUCTION OF BAMBOO AND BAMBOO PULP : ITS IMPORTANCE IN THE SOUTH-EAST ASIA

By Dr. Koichiro UEDA,
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D.5.1.

PRODUCTION OF BAMBOO AND BAMBOO PULP
- Its Importance in the South-East Asia -

I. BAMBOO RESOURCES
Dr. Koichiro Ueda Specialist Councillor, Resources Council, Science and Technics Agency, Japan.
II. PRODUCTION OF BAMBOO PULP
Dr. Kazuki Ono Specialist Councillor, Resources Council, Science and Technics Agency, Japan.

I. BAMBOO RESOURCES

1. The total surface area of bamboo distribution in the South-East Asian countries may be as large as 10 million ha. There exist a large number of species, and not a few species of genera, Bambusa, Dendrocalamus, Melocanna, Oxythenanthera, Schizostachyum, and Teinostachyum, offer ideal material for pulp production.
2. Most of the tropical species are of sympodial type. Many of their clumps stand in clump form, while some stand in single culm form (Melocanna, etc.). These two forms, however, appear to be interchangeable depending on conditions such as fertility of soil.
3. Let us assume the available surface area of bamboo forests as 5 million ha, and the mean annual bamboo culm production per ha in 2-3 year felling cycle as 3 tons, which is able to yield 1 ton of pulp. Then production of 5 million tons of pulp per year is quite possible.
4. The economical scale of a pulp paper factory generally requires production of at least 50,000 tons of pulp per year. Continuous operation of such a factory will require a group of densely distributed bamboo forests about 50,000 ha in total surface area.
5. In Japan, a bamboo paper making factory had been operated successfully for about 10 years, and produced about 5,000 tons of paper of good quality every year. Though its operation came to be suspended recently due to lack of bamboo resources, it had made considerable contributions to overcoming a number of disadvantages and had done important studies on improving productivity of bamboo forests.
6. New bamboo sprouts complete their growth to full size within a few months showing no further growth thereafter. Therefore, the annual increment per ha is the total sum of culms newly grown within the year. The yearly growth percentage of bamboo forest is as large as 20% with a good management. The most suitable cutting age is in the fourth year of its growth. The turnover percentage of capital in bamboo production is therefore much higher than in lumber production. It is also advantageous that no planting is needed after culms are felled and yielded, as bamboos propagate asexually by rhizomes.
7. These excellent features in growth and propagation, together with the immensity of bamboo forests in the region, make the production of bamboo pulp in the South-East Asia a promising industry. This enterprise will further be supported by its bamboo forests distributed rather conveniently for transportation and relatively flat landscape.
8. The South-East Asian climate also favors bamboo growth. The total length and weight of a culm in the tropical region are superior to those of a culm of

the same size growing in Japan. However, the total volume of bamboo or yearly increment (yield) per ha of a bamboo forest in the South-East Asia is inferior to those in Japan as shown in the following table. This difference is due to the poor management of bamboo forests in the former area.

Culm Yield (Increment) per Year per ha

Country	Species of bamboo	Culm yield (air dry weight)	Investigated by
Japan	Phyllostachys heterocycla var. pubescens	7.0-15.0 tons.	K. Ueda
	Ph. bambusoides	5.0-10.0 "	"
	Dendrocalamus strictus	3.0- 5.0 "	"
India	Bambusa arundinaria	5.0- 6.0 "	"
	Melocanna bambusoides	5.0- 6.0 "	"

9. In utilizing bamboos for pulp, reafforestation must be made as bamboo culms are felled, even if the surface area is large. Improper thinning is bound to lower the productivity of bamboo forests, and results in a marked hindrance on the operation of factories. It is desirable to fell grown-up bamboos in a 2-3 year felling cycle, always reserving young vigorous ones. The influences of the age, size and number of mother bamboos on annual yield have been investigated with radioisotope P^{32} and through other experiments. Fertilizing in summer also proved to be extremely effective in increasing yield in tropical bamboo forests.

10. If bamboo forests are left unattended after a gregarious flowering and death of bamboos, it takes them more than 10 years to recover their original vigor. The writer also conducted a successful research on the cause and proper treatment of flowering and death of bamboos.

11. Breeding bamboos suitable for pulp production is important. The writer and his colleagues have recommended chromosome study, X-ray irradiation, colchicine treatment, low temperature treatment of seeds, and so on.

II. PRODUCTION OF BAMBOO PULP

11. Under the present situation, bamboo pulp together with Bagasse Pulp is one of the essential resources for making paper of which production can be expected to increase in a large quantity in the South-East Asia. Althoughit is blessed with rich resources and a variety of useful bamboos for pulp, the bamboo pulp industry in these countries still remains without showing any remarkable development to speak of at present.

12. For one reason, this is attributable to the fact that the industrialization of these areas itself has been left behind, but for other important reasons, the progressive countries' pulp industries have little use for bamboo and naturally they have lacked knowledge as well as the exact know-how for dealing with bamboos and also for bamboo pulp production. For example, it is rather a matter of wonder that there still exists such an incorrect notion as to regard bamboo pulp in the same light as rice straw pulp.

13. From the view point of pulp resources, we have had theoretically as well as practically a successful results in the investigation and manufacture of bamboo pulp and paper for these past 10 odd years. Further, we have been co-operating in the promotion of several projects for a bamboo pulp industry in Indonesia and Burma etc., and also on obtaining a full knowledge of the circumstances there we have now realized that a bamboo industry in South-East Asia is the one of considerable concern and interest for us.

14. There are not a few new and outstanding discoveries on the physical and chemical properties of bamboo, such facts, in particular, have been made

evident and well-founded theoretically by anatomical analysis that its penetrability to chemical solution is very high, bamboo nodes do not present any impediment to pulping, and that fibre cells of the useful bamboos of South-East Asia are very long not less than "Trachide" of coniferous wood.

15. Furthermore, as the result of the chemical analysis of bamboo and investigations of the construction of components, there has been discovered many precise facts one of which is referred to in studies on the construction of lignin and its content. The contents of cellulose and hemicellulose of bamboo being very high, bamboos are quite adequate as a raw material for what is called holocellulose paper pulp; silica content is not so much.. It has also been shown by a research on polymerization grade and the distribution of bamboo cellulose molecules that bamboo pulp is suitable for rayon pulp.

16. At present the bleached kraft process is the most rational and advantageous one for bamboo among the well-known processes of pulp making, mainly being ascribed to the chemical property of bamboo lignin and its amount of content. Bleaching of bamboo pulp is easy and so-called fractional digestion is not necessary, and bamboo pulp yield as well as its quality is excellent compared with pulp of coniferous wood. Produced by this process, unbleached pulp is fit for making wrapping paper and bleached pulp for writing and printing paper, but for newsprint its process is still to be investigated for the future.

17. For bamboo, on account of its peculiar shape and the physical and chemical characteristics it has, it is not proper to use a woodchipper but necessary to think of a special device for it. We of course have a chipper for this special purpose having a considerably high ability in efficiency, power, as well as in uniformity of chips.

18. And bamboo, due to its form of fibres, has a singularity in the beating technique. Owing to its silica content, alkali recovering will not take place as in wood kraft pulp, but we have succeeded in getting the same rate of recovering as in wood kraft by our specially invented device.

19. Bleached bamboo pulp comes under a high grade one as for making writing or printing paper and would have much to do with development in blending with other pulp.

20. The material unit of bamboo pulp and paper manufacturing is better than that of coniferous wood. Under the present situation of South-East Asia, although there may exist many obstacles in starting a pulp industry such as importation of various materials and sub-materials, training of engineers and tenders, or securing of funds, all of these obstancles and disadvantages can be said to be the same as the developed countries once experienced.

21. Nevertheless, in view of the fact that rich resources, moderate in price, of high market value, and, what is more, in view of the acute shortage prevailing there, this industry in South-East Asia should be facilitated by giving it every assistance as possible.

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PRODUCTION OF BAMBOO AND BAMBOO PULP
- Its Importance in the South-East Asia -

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Dr. Kazuki Ono Specialist Councillor, Resources Council, Science and Technics Agency, Japan.

SUMMARY

1. At a time when pulp resources are running short throughout the world, bamboo, of which the cultivability is exceedingly high, can be said to be a superior source of pulp - but that now it is left as sleeping resource in an abundant quantity.
2. Although bamboo is a plant of very high increment, the management science of bamboo forest is still not developed enough and nothing is done scientifically or economically in its plantation and felling.
3. The useful bamboos for pulp of Japan come under the category of Phyllostachys. Where these kinds of bamboos are concerned, the bamboo forest management science has been brought up to a complete stage. The useful bamboos in South-East Asia such as Bambusa, Oxythenanthera, Schizostachyum, Dendrocalamus, Gigantochloa, Melocanna etc. differ more or less from Japanese Phyllostachys in physiology and usefulness, but the theory of bamboo forest management science derived from the Phyllostachys is applicable tothose bamboos in South-East Asia above referred to.
4. However, it should be remembered that viewed from the management point of view of bamboo forest, there are still many issues left for further investigation in making bamboos as the source for pulp in South-East Asia.
5. Regarding the bamboo pulp industry, there has been criticism even among specialists not only from the point of its raw material but also from such as its quality, use, cost. Therefore seeking the best and adequate pulping process for bamboo, we have carried out fundamental investigations on the physical and chemical properties of bamboo as well as on the manufacturing processes for its pulp, and also we have conducted comparative investigations and researches with wood pulp.
6. Parallel with our fundamental investigations and in concert with the factory in operation, our allout efforts have been incessantly poured into showing the characteristics of bamboo pulp and paper manufacturing.
7. As a result, we have discovered the fact that bamboo pulp industry is not disadvantageous in the least as compared with that of wood pulp and that it is rather more favourable from various points.
8. Bamboo in South-East Asia as raw material for paper pulp with a view to meeting the self-supplying policy will play an important role.
9. It is our firm belief in this industry that it will make a great contribution not only to the world pulp market but also to the prosperity of each nation there.

S - 854 E - Oct.1962 - 1,600

E/CONF.39/L/90
12 Oct.1962
ORIGINAL : ESPAÑOL

CONFERENCIA DE LAS NACIONES UNIDAS
SOBRE LA APLICACION DE LA CIENCIA Y LA TECNOLOGIA
EN BENEFICIO DE LAS REGIONES MENOS DESARROLLADAS

Punto del programa : D.5.4 Argentina

POSIBILIDADES DE NUEVAS FUENTES PRODUCTORAS DE GOMAS GALACTOMANANOS

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Las monografías presentadas en la Conferencia de las Naciones Unidas sobre la Aplicación de la Ciencia y la Tecnología en Beneficio de las Regiones Menos Desarrolladas constituyen documentos de trabajo de dicha Conferencia. Se publican tal como han sido presentadas por los colaboradores y los puntos de vista expresados en ellas corresponden a los colaboradores. (Véanse notas al dorso.)

NOTAS

1. Las monografías seleccionadas para las Sesiones Generales serán distribuidas en la Conferencia en los siguientes idiomas oficiales de las Naciones Unidas: español, francés, inglés y ruso.

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3. Los resúmenes de las monografías presentadas por los colaboradores serán distribuidos en la Conferencia en los siguientes idiomas oficiales de las Naciones Unidas: español, francés, inglés y ruso.

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POSIBILIDADES DE NUEVAS FUENTES PRODUCTORAS DE GOMAS GALACTOMANANOS

por Tomás Riquó, Doctor en Química

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1. Gomas vegetales galactomananos.

Las gomas vegetales son químicamente consideradas polisacáridos que, por sus propiedades físicas y químicas, encuentran gran demanda para fines industriales, según Whistler y BeMiller (a), solamente para la industria norteamericana es del orden de mil millones de libras (aproximadamente 5×10^8 kg = 500.000 toneladas) anuales.

La fuente natural de materias primas para la obtención de gomas vegetales corresponde a zonas geográficas bien determinadas y, generalmente, a regiones poco desarrolladas. Por la importancia de estos productos, en los países más evolucionados suele realizarse la explotación mediante cultivos artificiales de aquellos vegetales capaces de adaptarse en ambientes extraños a los propios de la especie (b, c, d) (figura I).

Dentro de este tipo de substancia encontramos las denominadas gomas-galactomananos; son de naturaleza hemicelulósica, obtenidas a partir de semillas de varias especies de la familia de las Leguminosas. La hidrólisis ácida de estas gomas produce, preferentemente, dos monosacáridos: galactosa y manosa en proporción aproximada de 30 y 60 por ciento, respectivamente. Estos son hidratos de carbono de estructura compleja, insolubles en solventes orgánicos, y con agua forman soles y geles de viscosidad elevada. Estas propiedades hacen que se las utilice en la industria como coloides protectores y sustancias gelificantes.

(a) Whistler, R.L. y BeMiller, J. N.; Industrial Gums, Academic Press, Nueva York (1959)

(b) Smith, F. y Montgomery, R.; The Chemistry of Plant Gums Mucilages, Reinhold Publishing Co., Nueva York (1959)

(c) Howes, F. N.; Vegetable Gums and Resins, Chronica Botanica Co., Massachusets (1949)

(d) Mantell, C.L.; The Water-Soluble Gums; Chronica Botanica Co., New York, (1947).

2. Usos industriales de las gomas galactomananos.

a) Industria textil.

Los espesantes y gelificantes en la industria textil generalmente se aplican según normas y técnicas estrictas que, a menudo, constituyen verdaderos secretos de fabricación. Rooleau (e) comunicó al autor que "gran parte del prestigio mundial obtenido por los tejidos ingleses se debe al apresto especial, y todavía relativamente secreto en su aplicación, elaborado a partir de semillas de Ceratonia siliqua". Estas gomas son indicadas para ser empleadas en las siguientes operaciones de la industria textil: encolado de la urdimbre, aprestos de hilos y tejidos, estampado y tinte de telas.

b) Pulpas celulósicas y papel.

El uso de estos productos en la fabricación de pastas celulósicas ha sido indicado por varios institutos de investigación tecnológica. Los términos contenidos en una carta del Sr. J. W. Swanson (f) del equipo técnico del Institute of Paper Chemistry, Appleton, Wisconsin, son elocuentes; en la misma dice: "las gomas galactomananos del 'algarrobo europeo' y del 'guar' han encontrado amplio uso en la industria papelera de los Estados Unidos. El empleo de estos materiales favorece la formación y distribución de las fibras, permitiendo fabricar papeles más resistentes."

Nuestros trabajos (g,h), realizados en colaboración con la industria privada, han permitido constatar, en el caso particular de la goma de "espina corona", lo siguiente: por agregado de 0,5% de esta goma en una pasta Kraft se logra disminuir el 20% del tiempo de refino. En soluciones de pH bajo o neutro resulta un buen encolante; no lo es en cambio en pH altos. Por último, las propiedades físicomecánicas se mejoran en los papeles en cuyas pastas fue adicionada goma galactomanano.

c) Industria alimenticia.

Estos productos se recomendaron como aditivos en el proceso de fabricación de helados y cremas heladas; se perfeccionan así las características organolépticas de los mismos. En la Argentina su mayor demanda se encuentra en la fabricación de dulces de batata y papa; además, en los últimos tiempos, se comercializa productos semielaborados para confiterías y heladerías en los cuales

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(e) Rooleau, F.; El Garrofín y otros Derivados del Algarrobo. Información personal (1951).

(f) Swanson, J. W., Institute Chemistry of Appleton, Wisconsin. Información personal (1956)

(g) Di Filippo, J.; La Goma de "Espina Corona". Su comportamiento en Refinación de Pastas. Celulosa Argentina S.A. Inédito. Buenos Aires (1956).

(h) Riquê, T.; Las Gomas Galactomananos y la Goma de "Espina Corona" en la Industria Papelera. IX Sesiones Químicas Argentinas, San Juan (1958)

interviene una proporción de goma galactomanano (i,j,k).

3. Evolución de su industria. Países productores y fuentes de materia prima de gomas galactomananos.

a) En Europa.

En los países que circundan el mar Mediterráneo crece el "algarrobo europeo" o "algarrobo del Mediterráneo" (Ceratonia siliqua), árbol cuyo cultivo y aprovechamiento, como forraje, se conoce desde la más remota antigüedad, (a,b,c,d,e,j,k,l). Sus frutos son legumbres rectas o encorvadas, denominadas algarroba o carobas; en su interior hay semillas ovales que contienen dos almendras amarillentas (albumen o endosperma), las cuales constituyen la base para la elaboración de la goma. Hace 60 años se desconocía totalmente el valor industrial de este tipo de gomas; fue una firma inglesa que en 1899 empezó a importar semillas de "algarrobo" de Chipre y elaboró, a partir de las mismas, un mucílago para uso en la industria textil. La importancia de ese mucílago alcanzó gran extensión, llegándose a exportarlo en grandes cantidades a los mismos países productores de materia prima, como Italia y España. Posteriormente, se instalaron otros establecimientos elaboradores de goma a partir de la semilla de Ceratonia siliqua en Holanda, Alemania, Suiza, Hungría y Francia.

Después de la Primera Guerra Mundial los italianos reaccionaron ante el absurdo de comprar en el extranjero, a precios elevados, un apresto obtenido de materia prima propia y que vendían a un precio relativamente bajo. Alrededor de 1925 a 1930 se instala en Palma de Mallorca, España, una fábrica para industrializar la semilla de "algarrobo" cosechada en la isla. Italia y España no solo llegan a autobastecerse sino a ser los principales exportadores de goma galactomananos. Más tarde, Portugal se suma como país productor y exportador (j,e).

Como consecuencia de la evolución industrial realizada en los países productores de semilla de Ceratonia, las fábricas alemanas, inglesas, suizas y holandesas encuentran dificultades crecientes en lograr materia prima. Esta situación no tendría solución inmediata en base a la semilla del "algarrobo europeo" debido a su limitación geográfica y a los años que necesita el árbol para

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(i) Rothman, B. y Riqué, T.; Las gomas Galactomananos y la goma de "Espina Corona" en la Elaboración de Productos Alimenticios. VII Congreso Latinoamericano de Química. Méjico (1959).

(j) Riqué, T. y Pardo L. L.; Estudio de la Goma Obtenida de Semillas de "Espina Corona" (Gleditsia amorphoides); Publicación Técnica Nº 19, Ministerio de Agricultura de la Nación - Buenos Aires (1954).

(k) Riqué, T.; Un Productor Forestal para las Industrias de la Alimentación. - Reunión Científica Extraordinaria de la Asociación Argentina de Nutrición y Dietología. 25 de septiembre de 1958. Rev. Dietología 17 47-53 (1959).

(l) Spada, A.; Estrazione della Gomma Contenuta nei Semi di Carruba e Caratteristiche della Gomma Stessa. Atti. Sco. Nat. Mod. 70 20 (1939).

entrar en producción; por estas razones algunas de las fábricas citadas industrializan semilla de "guar". Creemos que esos industriales juzgarían de interés el ofrecimiento de alguna otra materia prima capaz de ser industrializada para producir goma galactomanano en condiciones económicamente favorables (a).

b) En Estados Unidos.

En este país se emplean las gomas galactomananos en la elaboración de alimentos y en la industria de la celulosa y papel. Anteriormente satisfacía sus necesidades importándola de los países productores. Las dificultades originadas durante la Segunda Guerra Mundial en su abastecimiento normal, hizo que la importante industria de ese país estimulara a los institutos de investigación para buscar nuevas fuentes de producción en otras áreas geográficas. Esos trabajos, realizados en el Institute of Paper Chemistry en Appleton, Wisconsin, indicaron a la semilla de "guar" (Cyamopsis tetragonoloba) como probable reemplazante de la semilla de "algarrobo europeo" (a).

El "guar" es una planta anual, natural de la India, cultivada en Arizona, Nueva Méjico, y California, donde la producción ha alcanzado desarrollo económico; en pocos años, el consumo de goma de "guar" en los Estados Unidos igualó las cantidades de goma de "algarrobo" importada (m).

c) En la República Argentina.

Alrededor de 1935 llegan a nuestro país las primeras partidas de goma galactomanano, las cuales han sido utilizadas en la fabricación de dulces, especialmente el de batata y papa, aprovechando sus propiedades espesantes y gelificantes. En poco tiempo se crea un mercado interno que demanda cerca de 120.000 kg. por año.

En 1950 se produce en Argentina una aguda crisis de productos importados; entre estos, una gran escasez de goma de "algarrobo". Por esta razón, ciertos importadores trataron de hallar alguna semilla capaz de dar un producto semejante al importado. Para esa inquietud no tuvieron ningún cuidado en la selección de la semilla, prepararon distintos productos sin lograr ninguno que reuniera las propiedades gelificantes de la goma importada y, por lo tanto, no lograron cumplir con las exigencias de los usuarios de gomas galactomananos.

Pensando en la sinonimia de los nombres vernáculos de "algarrobo europeo" y "algarrobo negro" (Prosopis nigra), pretendieron utilizar la semilla de éste último pero tampoco lograron resultados promisorios. Estos intentos fueron realizados con marcado entusiasmo pero con más intuición especulativa, frente a la escasez del producto importado, que con conocimientos técnicos y científicos adecuados, recién frente a los repetidos fracasos solicitaron la intervención de organismos estatales especializados (j,n).

(m) Goldstein, A. M. y Alter, E.N.; Guar Gum. Industrial Gums, pag. 321. Academic Press - New York (1959).

(n) Riqué, T.; La goma de Espina Corona, Antecedentes y Desenvolvimiento de su Industria en la Argentina. Ing. Agr. 13 (Nov - Dic.) 30 - 35 - (1955).

Con el problema radicado en el instituto correspondiente, se constituyó una comisión técnica formada por un botánico y dos químicos; por especial indicación del primero (o), los trabajos fueron orientados hacia la especie forestal indígena "espina corona" (Gleditsia amorphoides) ya que desde el punto de vista botánico, dentro de la clasificación sistemática natural, aparece como la especie vegetal indígena más próxima y afín al "algarrobo europeo".

La citada especie crece espontáneamente en los bosques y selvas del norte argentino y se la encuentra en las provincias de Salta, Jujuy, Chaco, Formosa, Corrientes y Entre Ríos. Su área de distribución natural abarca también regiones adyacentes de Bolivia, Paraguay, Brasil y Uruguay. Su cultivo en nuestro país es raro y sólo se ha realizado ocasionalmente. (Figura II).

El fruto es una legumbre generalmente falcada, negruzca, de 6 a 8 cm de largo y 2 a 3 cm de ancho, indehiscente, algo pulposa, contiene en su interior 6 a 10 semillas de forma oblongo-ovoide de color oliváceo a canela. Del endospermo de estas semillas fue posible separar un producto capaz de reemplazar, por sus características físico-químicas y sus propiedades tecnológicas, a la goma galactomanano importada y obtenida de la semilla de la Ceratonia siliqua, (h,i,j,k,m,p).

Los interesados en su explotación comercial organizaron esa actividad, iniciando así una nueva demanda de mano de obra en toda la zona de distribución de la "espina corona" (Figura II). El primer centro de acopio se radicó en la localidad de Reconquista; posteriormente se establecieron otros en La Gallareta, Villa Guillermina y Villa Ana, todos en la provincia de Santa Fé; en Resistencia, Capitán Solari y General Obligado en la provincia del Chaco; en Pirané y en la ciudad de Formosa en la provincia del mismo nombre. Tres firmas privadas elaboraban goma de "espina corona"; una instalada en Avellaneda, localidad cercana a Reconquista en la provincia de Sante Fe, las otras dos en el Gran Buenos Aires. Estas últimas tuvieron dificultades en la compra de la materia prima (semillas), razón por la cual, hace dos años, vendieron sus instalaciones a una importante firma comercial dedicada a la comercialización e industrialización de productos forestales con instalaciones en la zona de La Escondida, Chaco, en el centro de mayor producción natural de "espina corona". Una tercera fábrica comenzará sus operaciones próximamente en la provincia de Salta, región donde esta especie es conocida con el nombre de "coronillo"; por último, se está realizando cultivos experimentales con "guar" en la provincia de Chaco, a cargo de instituciones privadas y estatales con miras a la industrialización de su semilla.

Esta industria ha creado un nuevo tipo de trabajo local: la población femenina, en los árboles más cercanos; los niños, entre sus correrías callejeras, y los hombres en las tareas más pesadas en el bosque, se dedican a la recolección de vainas de "espina corona"; recogen alrededor de 70 a 80 kg por persona y reciben entre dos y dos cincuenta pesos de moneda argentina (m$n 2.- a 2,50) por cada kilogramo de frutos entregados al acopiador, esto significa -

(o) Castiglioni, J.; Información personal. Botánico Forestal, Azcuénaga 1344, Buenos Aires, Rep. Argentina.

(p) Riquê, T. y Pardo, L. L.; La Goma de "Espina Corona" (Gleditsia amorphoides) Nueva Materia Prima para la Industria Farmacéutica. Rev. As. Bioq. Arg. 22 222-228 (1954).

una remuneración extra a la de sus tareas normales (n). Por su parte, los industriales le pagan a éste tres pesos (m$n 3.-) por kilogramo. Actualmente, las dos fábricas en actividad necesitan para abastecer el mercado interno una producción superior a 100.000 kg de frutos y una inversión, por parte de los fabricantes, de m$n 6.000.000.- para la adquisición de la materia prima. Esa cantidad iría a beneficiar a los pobladores de la zona anteriormente indicada (Figura II).

4. Posibilidades de nuevas fuentes de producción.

En esta memoria se reseña la importancia y la evolución del mercado mundial de gomas galactomananos, con especial indicación del proceso experimentado en la Argentina; se señala la diferente manera de proceder ante una situación similar, escasez en el mercado interno de goma galactomanano, en dos países: uno, Estados Unidos de Norteamérica, con experiencia y confianza en la industria y en la investigación tecnológica; el otro, Argentina, sin esas cualidades. En ambos, por vías diferentes en sus orígenes pero los dos por la investigación tecnológica al final, se logró encontrar otras fuentes naturales de materia prima para obtener gomas galactomananos.

Distintos investigadores (q) señalan que la demanda de este tipo de goma ha de ir en aumento a medida que se vaya conociendo sus excelentes propiedades para muchos usos. Vaticinan para la semilla de "algarrobo europeo" un porvenir halagüeño. En los Estados Unidos, el consumo de goma "guar", en sólo cuatro cosechas de semillas, ha pasado de una demanda de 1.250.000 kg a 7.500.000 kg, es decir, alcanzó la cifra de goma de "algarrobo europeo" importada por los americanos (m,r).

Las consideraciones realizadas nos hacen pensar que una investigación orientada hacia la búsqueda de otras semillas productoras de polisacáridos del tipo galactomanano resultaría, de ser positiva, una contribución de los conocimientos científicos y técnicos para promover una actividad económica y un aporte al desarrollo de la región geográfica donde la especie vegetal crece, pues la cosecha de los frutos y la industrialización de las semillas crearía trabajo, con nuevas fuentes de recursos y mayor demanda de mano de obra, con los consiguientes beneficios sociales que ello significa.

El Instituto Nacional de Tecnología Industrial, I.N.T.I., Buenos Aires, República Argentina, espera realizar, en el sentido indicado, un estudio sistemático con semillas de especies indígenas que se desarrollan en nuestro país. El nombrado Instituto podría, en colaboración con otras instituciones extranjeras e interesadas, contribuir a la búsqueda de otras fuentes productoras de gomas galactomananos como aporte de la tecnología en beneficio de regiones poco desarrolladas.

(q) García Martín, D. y Torres Ochoa, J.; Sobre la "Acacia de Tres Puas" (Gleditschia Triacanthos) y Especialmente sobre el Aprovechamiento de su Fruto. El Mucílago de sus Semillas y la Goma "Garrofín". Instituto Forestal de Investigaciones y Experiencias 29, 77 (1958) Madrid

(r) Rol, F.; Locust Bean Gum. Industrial Gums, pag. 361, Academic Press, Nueva York (1959).

Figura I

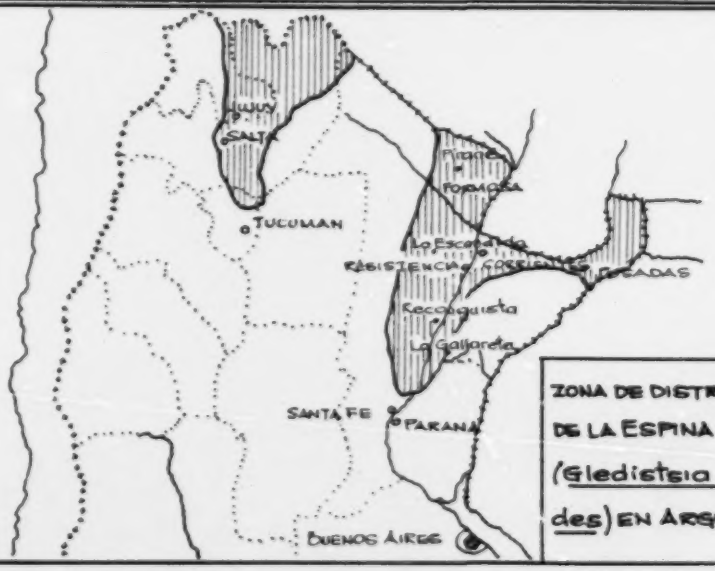
ZONA DE DESARROLLO DE LAS GOMAS VEGETALES MAS CONOCIDAS

- □ GOMA KARAYA (Esterculia urens)
- ■ GOMA ARABIGA (Acacia Senegal)
- ◪ GOMA KUTIRA (Cochlospernum gossypium)
- ▽ GOMA MESQUITA (Prosopis juliflora)
- ▼ GOMA DE OTRAS ACACIAS
- ⌂ GOMA DE ANGICO (Piptadenia Sp.)
- ⌂ GOMA GHATTI (Anogeissus latifolia)
- ◇ DERIVADOS DE ALGAS (AGAR, ACIDO ALGANICO, ETC.)
- ◆ GOMA TRAGACANTO (Astragalus)

GOMAS GALACTOMANANAS:
- ○ GOMA DE SEMILLA DE ALGARROBO (Ceratonia Siliqua)
- ● GOMA GUAR (Ciamopsis tetragonoloba)
- ● GOMA DE ESPINA CORONA (Gleditsia amorphoides)

Adaptado de Smith y Montgomery (b) y Howes (c).-

Figura II



ZONA DE DISTRIBUCION DE LA ESPINA CORONA (Gleditsia amorphoides) EN ARGENTINA.-

D/90

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SUMMARY

Agenda Item: D.5.4

Argentina

POSSIBILITIES OF NEW SOURCES FOR PRODUCING GALACTOMANNAN GUMS

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

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POSSIBILITIES OF NEW SOURCES FOR PRODUCING GALACTOMANNAN GUMS

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Vegetal gums are sources of labor as well as economical resources in certain geographic zones. In latter years, the so-called galactomannan gums, have gained significance, due to their many industrial applications. Up to the Second World War, the "Eropean carob" or "Mediterranean carob" (Ceratonia siliqua) was the only type of gum, the Mediterranean countries being the exclusive producers of the raw material while the United States of America and Great Britain were the greatest users.

The supply of galactomannan gum for the important American industry was very difficult during World War II. The American consumers, especially the cellulose and paper manufacturers, recommended to search for new sources of production in other geographical areas. The Institute of Paper , Appleton, Wisconsin, found out that the "guar" seed (Cyamopsis tetragonoloba), an annual plant of India, contains a mucilage of similar characteristics to that obtained from the Ceratonia siliqua.

In 1950 a lack of imported products came about in Argentina amongst them was the European carob gum; many importers of this item tried to find a substitute, using several seeds; after repeated failures, they consulted the specialized Institutes. A technical committee, formed by a botanist and two chemists, proved the presence of galactomannan gum in the seed of an indigenous forest species called "espina corona" or "coronillo" (Gleditsia amorphoides)and pointed out the possibilities for using it, giving also directions on the processing methods. It should be interesting to comment on the different procedures followed when confronted with a similar situation of(short age of galactomannan gums in the internal market): in the United States they had experience and were relying on technological investigation; in Argentina, we had none of these qualifications. But in both countries it was possible by

differnt ways, and only by technological search, to find other natural sources of raw materials for obtaining galactomannan. gums.

United States uses at present nearly 7.500.000 kg of "guar" gum and a similar amount of European carob from Europe.

The Argentine Republic has a market of some 120.000 kg of this gum type, used nearly wholly as jellifying agent in manufacturing sweet preserves; private firms manufacture and comercialize the gum of "espina corona", aiming to satisfy local demand; for this purpose it would be necessary to harvest 2.000.000 kg of fruit; at the rate of 3 pesos per kilo this would mean an investment from the manufacturer's side, of some 6.000.000.- pesos for the raw material acquisition. This sum would benefit the people of the production area of the Gleditsia amorphoides, which covers a large northern area of scarce population and little industrialization. Beside reaching the given yielding figure, this would mean for the Argentina a grater foreign exchange availability when avoiding the expence of importation from present producing countries. Finally we would like to point out that experimental cultures are being conducted with "guar" seed in several regions of the country aiming at the whole utilization of the species.

Due to the growing demand of galactomannan gum we bilieve that there are real advantages in using local raw materials able to yield that type of jellifying agent. A search aiming to find other seeds rendering that type of polysaccharides, should be -if successful- a contribution of science and technology to the economical development of the areas where these vegetal species grows, since the harvesting and the industrialization of seeds will create labor possibilities, i.e., new resources and grater demand of labor with the resulting social benefits.

The National Institute of Industrial Tedhnology (Instituto Nacional de Tefnología Industrial, I.N.T.I.) in Buenos Aires, Argentina, hopes to conduct a systematical study of the species of indigenous seeds growing in our country. Said Institute, cooperating with other interested Organizations abroad, could be helped the searching of other sources of galactomannan gums, as a contribution of technology for the benefit of poorly developed regions.

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